



Measuring Cement Powders and Slurries Using ColorFlex® L2

Introduction

Color consistency in cement is a visible indicator of raw material balance, processing stability, and production quality. Even subtle color differences in cement powders or slurry mixes can signal variations in chemistry, kiln conditions, moisture levels, or blending consistency.



Because cement and concrete products are often installed in large continuous areas—such as pavements, architectural panels, and precast structures, small color shifts can become highly visible in the final application.

Traditional visual inspection is subjective and strongly influenced by lighting conditions, moisture, and observer perception. To eliminate these variables, many cement producers rely on spectrophotometric color measurement to provide objective, repeatable color data.

By measuring cement powders and slurries with ColorFlex L2, manufacturers can monitor production consistency, detect process deviations earlier, and maintain consistent appearance across batches and production sites. This proactive control helps reduce scrap costs by identifying off-spec material before it progresses through production, while also minimizing quality-related costs associated with customer complaints, rework, and returns. Ultimately, consistent color performance protects brand reputation by ensuring that every delivered product meets visual expectations and reinforces customer confidence.



Color Challenges in Cement Production

Raw Material Variability

The color of cement powder is influenced by the chemical composition of raw materials such as limestone, clay, iron oxides, and supplementary cementitious materials. Natural variation in these materials can cause shifts in brightness and hue even when formulations remain unchanged.

Moisture and Slurry Effects

Cement slurry mixes appear darker and slightly different in color compared to dry powders. Moisture content and water-cement ratio influence how light reflects from the material surface.

Measuring slurry color helps monitor:

- mixing consistency
- pigment dispersion
- early-stage process stability

Batch-to-Batch Variability

Cement is produced in continuous or batch processes. Small variations between batches can create noticeable color differences in downstream concrete products.

Color measurement allows producers to quickly detect these variations before the material is used in production.

Recommended Measurement Method for Cement Powders and Slurries

Reflectance Spectrophotometry



Reflectance spectrophotometry provides objective color measurement independent of lighting conditions and observer perception.

For cement powders and slurry mixes, best practices include:

45°/0° Geometry

- Measures color the way the human eye sees it
- Ideal for matte, gloss and textured materials like cement powders and slurries

CIE D65 Illumination

- Simulates daylight viewing conditions
- Ensures consistent comparison across facilities

CIELAB Color Space

- L* represents lightness
- a* represents red/green
- b* represents yellow/blue

ΔE Color Difference

- Used to determine whether a sample meets color tolerances relative to a standard.

Multiple measurements are typically averaged to account for natural material heterogeneity.

Recommended Instrument for Cement Measurement

HunterLab ColorFlex® L2 Spectrophotometer

The ColorFlex L2 is well suited for laboratory and at-line color control of cement powders and slurry mixes.

Key advantages include:



45°/0° directional geometry

- Closely correlates with human visual perception
- Ideal for cement powders and slurries

Large measurement apertures

- Average color across aggregates or surface variation

Excellent repeatability

- Supports batch-to-batch production monitoring

Robust industrial design

- Suitable for cement and concrete manufacturing environments

Integrated touchscreen software

- Enables standalone operation without a PC

The instrument is commonly used to:

- Establish master color standards for cement production
- Monitor batch consistency
- Verify pigment additions and mix uniformity
- Document color compliance for production and quality records.

Measuring Cement Powders with ColorFlex L2

Cement powders can be measured quickly and reliably using the HunterLab ColorFlex L2 Spectrophotometer with a standard sample cup or powder container. Proper sample preparation is important to ensure that the measured color represents the bulk material rather than localized surface variation.



Standard Sample Cup Method

This method is commonly used for routine laboratory and at-line quality control.

Typical procedure:

- Fill a sample cup with cement powder.
- Gently tap the cup to remove voids.
- Place the sample cup on the measurement port.
- Take three measurements, rotating the sample cup ninety degrees between each measurement.
- Average the results.
- Compare the sample to established color standards.

Multiple readings are recommended to account for natural heterogeneity in cement powders.

ASTM Dump-and-Fill Method (Alternative Method)

For loose granular materials and powders, ASTM measurement practices commonly recommend a dump-and-fill technique to improve statistical representation of the material.

Typical procedure:

- Fill a container or sample cup with cement powder.
- Gently tap the cup to remove voids.
- Measure the sample.
- Empty (dump) the sample and refill the container with the same material.
- Repeat this process three times.
- Average the results.

This method reduces the influence of:

- Particle orientation
- Localized compaction



- Surface leveling effects

By measuring multiple freshly filled samples, the dump-and-fill approach provides a better statistical representation of the bulk powder color, which is particularly useful for materials such as:

- Cement powders and slurries
- Mineral pigments
- Granular aggregates

Best Practices for Cement Powder Measurement

- For the most reliable results:
- Perform multiple measurements and average results.
- Use consistent sample preparation procedures.
- Use CIELAB color values (L^* , a^* , b^*) and ΔE tolerances to monitor batch consistency.

These practices help ensure that measured color reflects the true appearance of the cement material and supports consistent quality control across production batches.

Measuring Cement Slurry Mixes

Cement slurry can also be measured to evaluate color early in the mixing process.

Recommended approach:

1. Prepare a representative slurry sample.
2. Pour the slurry into a sample cup or measurement container.
3. Gently tap the sample cup to remove any voids or bubbles.
4. Place the sample cup on the measurement port.
5. Take three measurements, rotating the sample cup ninety degrees between each measurement.
6. Average the results.



7. Compare the sample to established color standards.

Comparing slurry color to powder or standard values can help detect:

- Water ratio changes
- Pigment dispersion issues
- Raw material variation

Case Study: Cement Production Consistency

Background

A cement producer experienced inconsistent color in finished concrete products used in architectural applications. ADD COST SECTION

Challenge

Visual inspection of cement powders failed to detect subtle variations caused by changes in raw materials and kiln conditions.

Solution

The manufacturer implemented ColorFlex L2 in the quality control laboratory to measure cement powder color for each production batch.

CIE L*, a*, b* color standards and ΔE tolerances were established for acceptable production ranges.

Results

- Improved consistency between cement batches
- Faster detection of raw material variation
- Reduced downstream color issues in concrete products
- Objective documentation for quality assurance



Standards and References

Spectrophotometric color measurement for cement aligns with widely accepted international standards.

ASTM Standards

- **ASTM E308** - Calculation of Object Color Using the CIE System
- **ASTM D2244** - Color Differences and Tolerances
- **ASTM E1164** - Spectrophotometry geometry standards

ASTM Reference Note – Dump-and-Fill Sampling for Powder Measurements

ASTM spectrophotometric color measurement standards such as ASTM E1164 and ASTM E308 emphasize the importance of proper sample presentation and statistical sampling when measuring heterogeneous materials.

Loose powders and granular materials, including cement powders—can exhibit color variation due to:

- Particle Orientation
- Packing density
- Particle size distribution
- Localized composition differences

Because of these effects, ASTM practices commonly recommend multiple independent measurements a sample rather than relying on a single static surface.

The dump-and-fill method supports this principle by:

- Randomly redistributing particles between measurements
- Minimizing compaction and surface leveling bias
- Improving the statistical representation of the bulk material



When several dump-and-fill measurements are averaged, the resulting color values provide a more reliable estimate of the true color of the material.

From a statistical perspective, repeated independent measurements reduce the influence of sampling variability and improve confidence in the reported mean color value. In quality control environments, this leads to:

- Improved repeatability (s_r)
- Stronger confidence intervals for mean color values
- More reliable ΔE pass/fail decisions when comparing to production tolerances.

CIE Standards

The CIELAB Color Space and ΔE^* Color Difference, established by the International Commission on Illumination, provides a framework for color measurement and representation based on human vision, and is considered the international benchmark for color measurement and representation, providing a standardized method for quantifying color. By establishing a common framework, the CIE standards facilitate communication and collaboration across different industries and disciplines.

These **ASTM** and **CIE** standards ensure color measurement results are consistent across laboratories and production facilities.

Conclusion

Color measurement provides cement manufacturers with a powerful diagnostic tool for monitoring raw materials, mixing conditions, and production consistency.

By implementing standardized spectrophotometric measurement using ColorFlex L2, producers gain objective color data that supports process control, reduces variability, and ensures consistent appearance in cement and concrete products.